6M3P

DS-1x-06M03

2.75 fps 3k x 2k

CCD Camera

User's Manual and Reference

Doc #: 03-32-10005

Rev: 02

DALSA
technology with vision

© 2002 DALSA. All information provided in this manual is believed to be accurate and reliable. No responsibility is assumed by DALSA for its use. DALSA reserves the right to make changes to this information without notice. Reproduction of this manual in whole or in part, by any means, is prohibited without prior permission having been obtained from DALSA.

About DALSA

DALSA is an international high performance semiconductor and electronics company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing wafer foundry services. DALSA's core competencies are in specialized integrated circuit and electronics technology, and highly engineered semiconductor wafer processing. Products include image sensor components; electronic digital cameras; and semiconductor wafer foundry services for use in MEMS, power semiconductors, image sensors and mixed signal CMOS chips.

DALSA is a public company listed on the Toronto Stock Exchange under the symbol "DSA". Based in Waterloo, On. Canada, the company has operations in Bromont, PQ; Colorado Springs, CO; Tucson, AZ; Eindhoven, NL; Munich, Germany and Tokyo, Japan.

All DALSA products are manufactured using the latest state-of-the-art equipment to ensure product reliability.

DALSTAR refers to all DALSA area scan products.

For further information not included in this manual, or for information on DALSA's extensive line of image sensing products, please contact us.

DALSA Sales Offices

Waterloo	Europe	Asia Pacific
605 McMurray Rd Waterloo, ON N2V 2E9 Canada Tel: 519 886 6000 Fax: 519 886 8023 www.dalsa.com sales@dalsa.com	Breslauer Str. 34 D-82194 Gröbenzell (Munich) Germany Tel: +49 - 8142 – 46770 Fax: +49 - 8142 – 467746 www.dalsa.com europe@dalsa.com	Space G1 Building, 4F 2-40-2 Ikebukuro Toshima-ku, Tokyo 171-0014 Japan +81 3 5960 6353 (phone) +81 3 5960 6354 (fax) www.dalsa.com asia@dalsa.com

DALSA Worldwide Operations

Waterloo	Colorado Springs	Tucson	Europe	Asia Pacific
605 McMurray Rd Waterloo, ON N2V 2E9 Canada Tel: 519 886 6000 Fax: 519 886 8023 www.dalsa.com sales@dalsa.com	5055 Corporate Plaza Drive Colorado Springs, CO 80919 USA Tel: 719 599 7700 Fax: 719 599 7775 www.dalsa.com sales@dalsa.com	3450 S. Broadmont Dr. Suite #128 Tucson, AZ 85713-5245 USA Tel: 520 791 7700 Fax: 520 791 7766 http://lifesciences.dalsa.com sales@dalsa.com	Breslauer Str. 34 D-82194 Gröbenzell (Munich) Germany Tel: +49 - 8142 – 46770 Fax: +49 - 8142 – 467746 www.dalsa.com europe@dalsa.com	Space G1 Building, 4F 2-40-2 Ikebukuro Toshima-ku, Tokyo 171-0014 Japan +81 3 5960 6353 (phone) +81 3 5960 6354 (fax) www.dalsa.com asia@dalsa.com

Contents

Introduction to the 6M3P Camera 5

1.1 Camera Highlights 5
1.2 Image Sensor 6
1.3 Camera Performance Specifications 8

Camera Hardware Interface 10

2.1 Installation Overview 10
2.2 Input/Output 10
2.3 LED Status Indicators 11
2.4 Power Input 12
2.5 Data Output 13
2.6 Serial Communication 14
2.7 TTL Trigger Input and Output 16
2.8 Integration Time 16
2.9 Timing 17

Camera Operation 21

3.1 How to Control the Camera 21
3.2 Control Register Reference 22
3.3 Reading the Camera Type 23
3.4 Reading the Firmware Revision 23
3.5 Resetting the Camera 23
3.6 Adjusting Gain 24
3.7 Adjusting User Offset 24
3.8 Controlling Binning 25
3.9 Triggering, Integration, and Frame Rate Overview 26
3.10 Controlling Integration (Shutter Time) 27
3.11 Controlling Frame Rate 30

Optical and Mechanical Considerations 32

4.1 Mechanical Interface 32
4.2 Mechanical Tolerances 33
4.3 Mounting the Camera 33

Cleaning and Maintenance 34

5.1 Cleaning 34

5.2 Maintenance 36

Troubleshooting 37

Warranty 38

7.1 Limited One-Year Warranty 38

Index 39

1

Introduction to the 6M3P Camera

1.1 Camera Highlights

Features

- 3072 x 2048 resolution, Full-frame CCD architecture.
- 2.75 fps one output at full resolution, 20 MHz data rate
- True 12-bit digitization
- High sensitivity with low dark current
- Progressive scan readout
- Asynchronous image capture, externally triggerable to within 200 ns.
- Selectable binning up to 8 x 8
- Programmable operation via RS232, including gain (1x and 4x) , offset (-2047 to + 2048), frame rate, binning, and triggering.
- 100% fill factor

Description

The 6M3P digital camera provides high-sensitivity 12-bit images with 3k x 2k spatial resolution at up to 2.75 frames per second (fps). The 6M3P is a Full Frame CCD camera using a progressive scan CCD to simultaneously achieve outstanding resolution and gray scale characteristics. A square pixel format and high fill factor provide superior, quantifiable image quality even at low light levels.

Applications

The 6M3P is an outstanding performer in fast, very high resolution applications. True 12 bit performance provides up to 4096 distinct gray levels—perfect for applications with large interscene light variations. The low-noise, digitized video signal also makes the

camera an excellent choice where low contrast images must be captured in challenging applications.

1.2 Image Sensor

Figure 1. Image Sensor Block Diagram

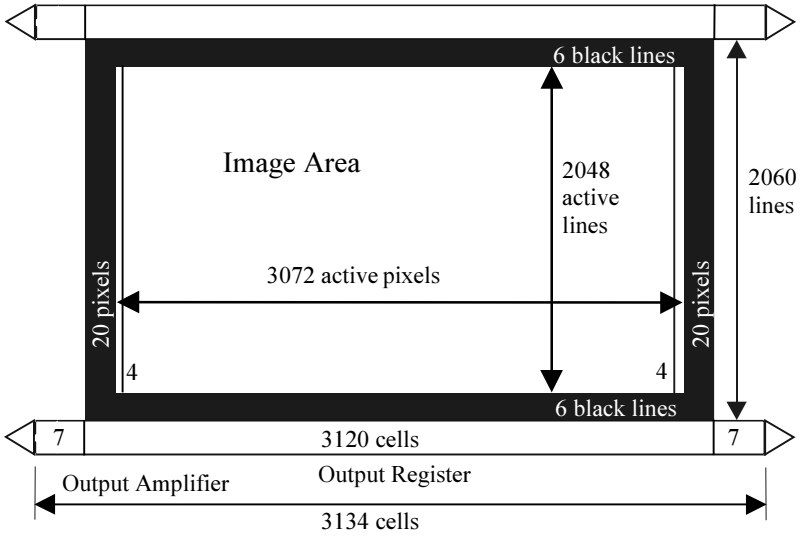


Table 1. Sensor Structure

Sensor characteristics	
Optical size	36.864mm (H)x24.576 mm (V)
Chip size	39.148 mm (H)x26.508 mm (V)
Pixel size	12µm x 12µm
Active pixels	3072 (H) x 2048 (V)
Total number of pixels	3120 (H) x 2060 (V)
Optical black pixels	Left: 20 Right: 20
Timing pixels	Left: 4 Right: 4
Dummy register cells	Left: 7 Right: 7
Optical black lines	Bottom: 6 Top: 6

Table 2. Sensor Cosmetic Specifications

Type	Allowable Blemishes
Columns	1
Clusters	6
Pixels	36

Definition of blemishes

Pixel defect

- Pixel whose signal, at nominal light (illumination at 50% of the linear range), deviates more than ±30% from its neighboring pixels.
- Pixel whose signal, in dark, deviates more than 6mV from its neighboring pixels (about 1% of nominal light).

Cluster defect

- A grouping of pixel defects where within a sub area of 3*3 pixels there are at most 5 present.

Column or row defect

- A column or row which has more than 12 pixel defects.
- Column defects must be horizontally separated by 3 columns.
- Row defects are not allowed.

Test conditions

- Temperature : 35°C
- Integration Time : 10 ms

1.3 Camera Performance Specifications

Table 3: 6M3P Camera Performance Specifications

Physical Characteristics	Units				
Resolution	H x V pixels	3072x2048			
Pixel Size	µm	12x12			
Pixel Fill Factor	%	100			
Size	mm	95x95x142			
Mass	kg	0.85			
Power Dissipation	W	< 17			
Lens Mount		F , M72, or M72 color mount			
Aperture	mm	36.9x24.6			
Regulatory Compliance		Pending			
Shock Immunity		Pending			
Vibration Immunity		Pending			
Operating Ranges	**Units**	**Min.**	**Max.**		
Frame Rate	fps	2.75	12.5		
Data Rate	MHz	2.5	20		
Data Format	LVDS/RS422		12 bit		
Operating Temp	°C	10	45		
Responsivity	DN/(nJ/cm^2)		19@540nm		
+15 Input Voltage	V	+14.925	+15.075		
+5 Input Voltage	V	+4.975	+5.025		
-5 Input Voltage	V	- 4.975	- 5.025		
Nominal Gain Range		1x	4x		
Calibration Conditions	**Units**	**Setting**	**Min.**	**Max.**	
Data Rate	MHz	20	20	20	
Frame Rate	Hz	2.75			
+15 Input Voltage	V	+15	+14.925	+15.075	
+5 Input Voltage	V	+5	+4.975	+5.025	
-5 Input Voltage	V	- 5	- 4.975	- 5.025	
Ambient Temperature	°C	25			
Binning		1x1			
Gain	X	1			

Electro-Optical Specifications	Units	Min.	Typical	Max.	
Dynamic Range	**dB**		**70**		
Pixel Response Non-Uniformity	%rms		2		
System Noise	DN(rms)		0.9		

2

Camera Hardware Interface

2.1 Installation Overview

This installation overview assumes you have not installed any system components yet.

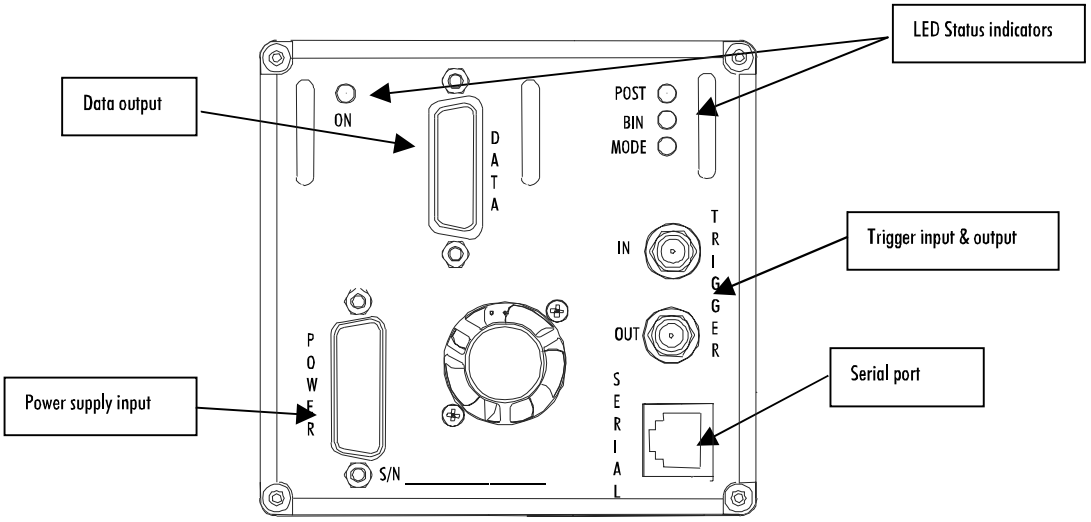
In order to set up your camera, you should take these initial steps:

1. Power down all equipment.
2. Following the manufacturer's instructions, install the frame grabber (if applicable). **Be sure to observe all static precautions.**
3. Install any necessary imaging software.
4. Before connecting power to the camera, test all power supplies. **Ensure that all the correct voltages are present at the camera end of the power cable** (the Camera Performance Specifications earlier in this document list appropriate voltages). Power supplies must meet the requirements defined in section 2.4 Power Input.
5. Inspect all cables and connectors prior to installation. Do not use damaged cables or connectors or the camera may be damaged.
6. Connect data, serial interface, and power cables.
7. After connecting cables, apply power to the camera. The POST (power on self test) LED on the back of the camera should glow green after one second to indicate that the camera is operating and ready to receive commands.

2.2 Input/Output

The camera provides 12-bit LVDS/RS-422 data and synchronization signals through the data output connector. Camera functions such as frame rate, integration time, binning, camera gain and offset are all controllable by the user via RS232 serial port. The camera is capable of free running operation or may be triggered externally via the input TRIGGER IN. TRIGGER OUT allows the synchronization of shutters or illumination sources in free running or externally triggered modes.

Figure 2: Camera Inputs/Outputs



2.3 LED Status Indicators

There are four LED's visible on the rear cover of the camera that indicate the status of the camera.

Table 4: LED Functions

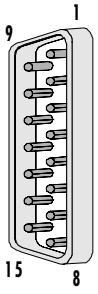
LED Label	Color	LED "ON"	LED "OFF"
ON	Green	Camera is receiving power	There is no camera power
POST	Green	Camera Power On Self Test successful	Camera failed Power On Self Test
BIN	Red	Camera is operating in a binning mode	Camera is operating unbinned (1x1)
MODE	Red	Camera is in an external trigger mode (uses external signal to trigger image capture)	Camera is triggering image capture internally

2.4 Power Input

WARNING: It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage the camera.

Table 5: Power Connector Pinout

Pin	Symbol
1	+5V
2	+5V
3	- 5V
4	+15V
5	NC
6	NC
7	GND
8	GND
9	+5V
10	- 5V
11	+15V
12	NC
13	NC
14	GND
15	GND



DB15M

(AMP Part # 747236-4 or equivalent)

The camera has the following input power requirements.

V (DC)	±%	Max Ripple mV	A
+15	0.5	< 5	0.45
+5	0.5	< 5	1.4
-5	0.5	< 5	0.25

Note: Performance specifications are not guaranteed if your power supply does not meet these requirements.

DALSA offers a linear power supply (with cables) that meets the 6M3P's requirements (Universal Power Supply, part number 24-00001-02, contact DALSA for more information), but it should not be considered the only choice. Many high quality supplies are available from other vendors. DALSA assumes no responsibility for the use of these supplies.

When setting up the camera's power supplies, follow these guidelines:

- Do not connect or disconnect cable while power is on.
- Do not use the shield on a multi-conductor cable for ground.
- Keep leads as short as possible to reduce voltage drop.
- Use high-quality **linear** supplies to minimize noise.

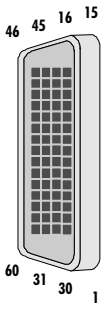
2.5 Data Output

The camera back panel output connector labeled DATA utilizes differential LVDS signals with pin assignments as follows:

Connector and Pinout

Table 6: DATA Connector Pinout

Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	DA0+	16	Reserved	31	NC	46	GND
2	DA0-	17	DA7+	32	NC	47	NC
3	DA1+	18	DA7-	33	NC	48	NC
4	DA1-	19	DA8+	34	NC	49	NC
5	DA2+	20	DA8-	35	NC	50	NC
6	DA2-	21	DA9+	36	NC	51	NC
7	DA3+	22	DA9-	37	NC	52	NC
8	DA3-	23	DA10+	38	NC	53	Reserved
9	DA4+	24	DA10-	39	NC	54	Reserved
10	DA4-	25	DA11+	40	NC	55	VSYNC-
11	DA5+	26	DA11-	41	NC	56	VSYNC+
12	DA5-	27	NC	42	NC	57	HSYNC-
13	DA6+	28	NC	43	NC	58	HSYNC+
14	DA6-	29	NC	44	NC	59	PIXCLK-
15	Reserved	30	NC	45	GND	60	PIXCLK+



(Molex Part # 70928-2000 or equivalent)

NC = No Connect. These pins are unused.

WARNING. Care must be taken when connecting Data cables to the camera to insure proper connection and to prevent damage to the connector.

Data Signals

Table 7: Data Signal Definition

Signal	Description
D*0+, D*0-	Data bit 0 true and complement--Output. (Least significant bit)
D*1+, D*1-	Data bit 1 true and complement--Output.
D*2+, D*2-	Data bit 2 true and complement--Output.
D*3-D*10+,- etc.	Etc.
D*11+, D*11-	Data bit 11 true and complement--Output. (Most significant bit)

IMPORTANT:
This camera uses the ***falling*** edge of the pixel clock to register data.

Digitized video data is output from the camera as LVDS differential signals using a Molex 60-pin connector on the rear panel (labeled "DATA"). The data is synchronous and is accompanied by a pixel clock and clocking signals.

Note: Data frequency is dependent on binning mode. Reference section 3.9 – Triggering, Integration, and Frame Rate Overview.

Data Clocking Signals

Table 8: Clock Signal Descriptions

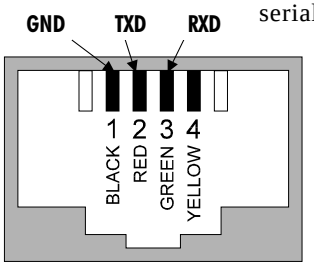
Signal	Description
PIXCLK+, PIXCLK-	Pixel clock true and complement. 20MHz (unbinned) -- Output. Data is valid on the falling edge. Note that data and PIXCLK frequency is dependent on binning mode. Reference section 3..9 – Triggering, Integration, and Frame Rate Overview
HSYNC+, HSYNC-	Horizontal sync, true and complement--Output. HSYNC high indicates the camera is outputting a valid line of data. The number of valid lines in a frame depends on binning mode. Reference section 3.9 – Triggering, Integration, and Frame Rate Overview.
VSYNC+, VSYNC-	Vertical sync, true and complement--Output. VSYNC high indicates the camera is outputting a valid frame of data.

2.6 Serial Communication

Connector and Pinout

The serial interface provides control of frame rate, integration time (shuttering), video gain and offset, pixel binning, external trigger and external integration (for information on how to control these functions, see "Operating the Camera" later in this document). The remote interface consists of a two-wire (plus ground) full duplex RS-232 compatible serial link, used for camera configuration, and two back panel SMA coax connectors used for external trigger input and output

The camera uses an RJ-11 telephone-style connector for serial communications, with four conductors installed in a six-position connector. Note that both four- and six-conductor plugs may be used interchangeably with the RJ-11 jack.



RJ-11
View into female jack
6-position with 4 conductors

IMPORTANT: Both the PC / AT and the camera are configured as "DTE" (Data Terminal Equipment) devices requiring the TXD and RXD lines to be swapped when interconnecting the two (note that pin 4, normally the yellow wire, is not used on the RJ-11.) That is, the TXD pin represents DATA OUT and the RXD pin represents DATA IN on both devices, so that one device's TXD line must connect to the other device's RXD line and vice-versa.

Figure 3: 25 Pin Serial Port Connector to Camera RJ-11 Connector

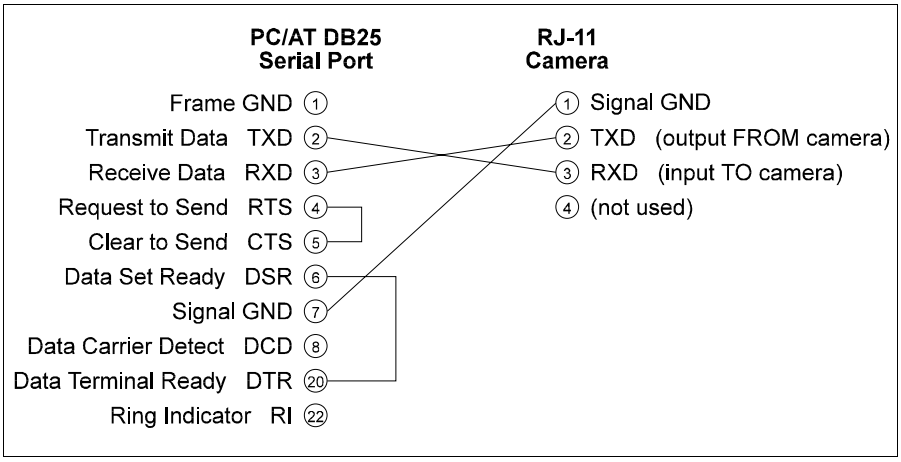
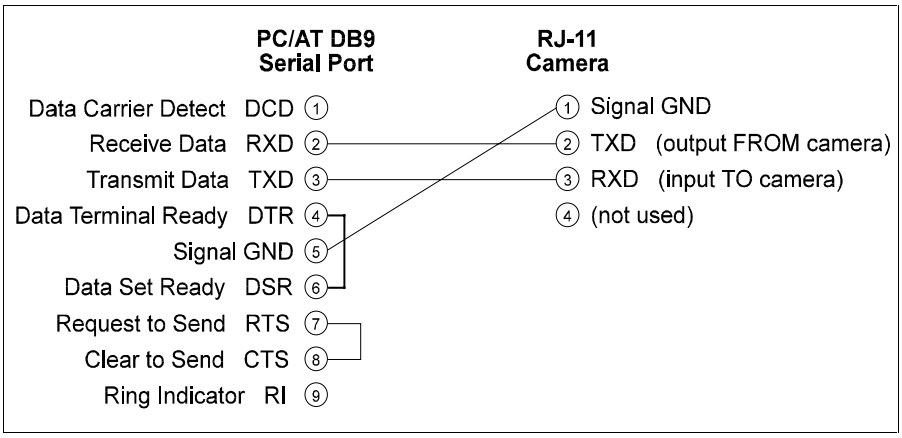


Figure 4: 9 Pin Serial Port Connector to Camera RJ-11 Connector



Serial Communication Settings

Table 9: Serial Port Configuration

Serial Port Configuration	
Baud	9600, fixed
Start bits	1
Data bits	8
Stop bits	1
Parity	None

The serial interface operates at RS-232 levels with fixed parameters of 9600 baud, 1 start bit, 8 data bits, 1 stop bit, and no parity. The interface uses only three wires, for received data, transmitted data, and ground. In general writing data must start with a write command byte and be followed by a data byte. Reading a camera register requires only a single read command byte.

WARNING: Due to initialization sequencing after power-up, no commands should be sent to the camera for a minimum of 1 second after power up.

The remote interface connector, on the cameras rear panel, is specified as a low-profile RJ-11 modular connector. The connector is a 6-position model, but only the center four positions are populated with contacts. It will mate with either the 4-position or 6-position cable plugs. This type of connector typically requires special assembly tools; complete cable assemblies are available from suppliers such as Digi-Key:

Serial Cable Source

Digi-Key
701 Brooks Ave. South
Thief River Falls, MN 56701
1-800-344-4539
cable part number:
H2643-14-ND (14 feet)

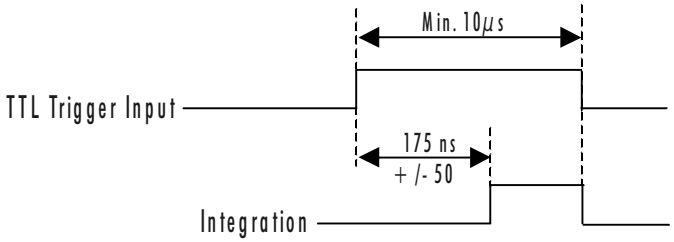
DALSA provides serial cables in 3 lengths: 10', 20' and 50'. Part number CL-31-00004-xx (where xx refers to the cable length in feet).

2.7 TTL Trigger Input and Output

Connector

The camera uses an SMA connector (labeled TRIGGER IN) to allow the user to provide a standard TTL signal to control camera integration and readout. The input is high impedance (>10K) allowing the user to terminate at the SMA input as needed. The camera has another SMA connector (TRIGGER OUT) that provides a standard TTL output which is high whenever the camera is integrating.

Figure 5: Trigger Timing Description



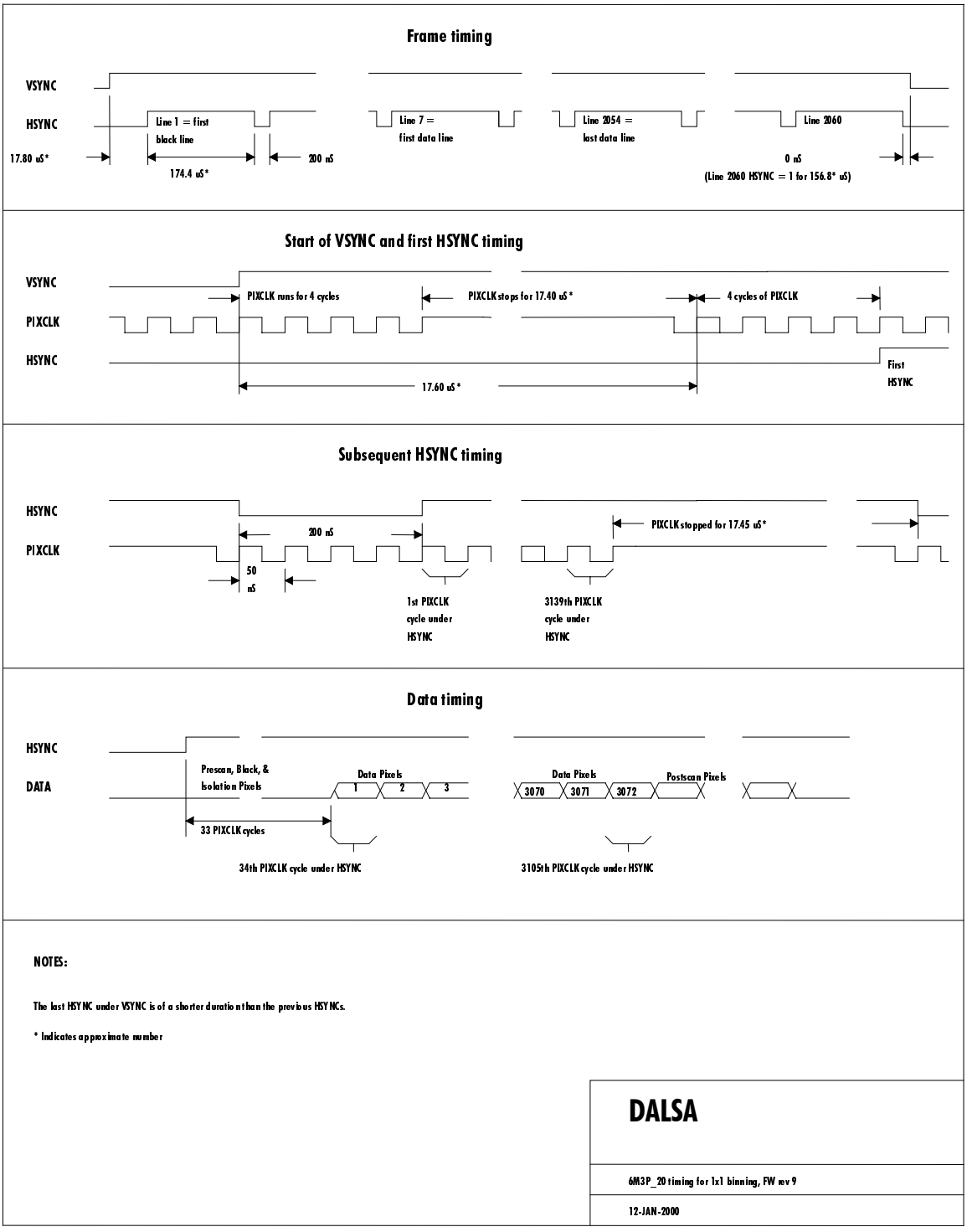
2.8 Integration Time

The minimum integration time (or shutter time) is 10 µs. If the camera is not strobed or externally shuttered, an integration time of 10 µs will create smeared images. To reduce smearing, the integration time should be 1.5x to 2x the readout time when not using a strobe or external shutter.

2.9 Timing

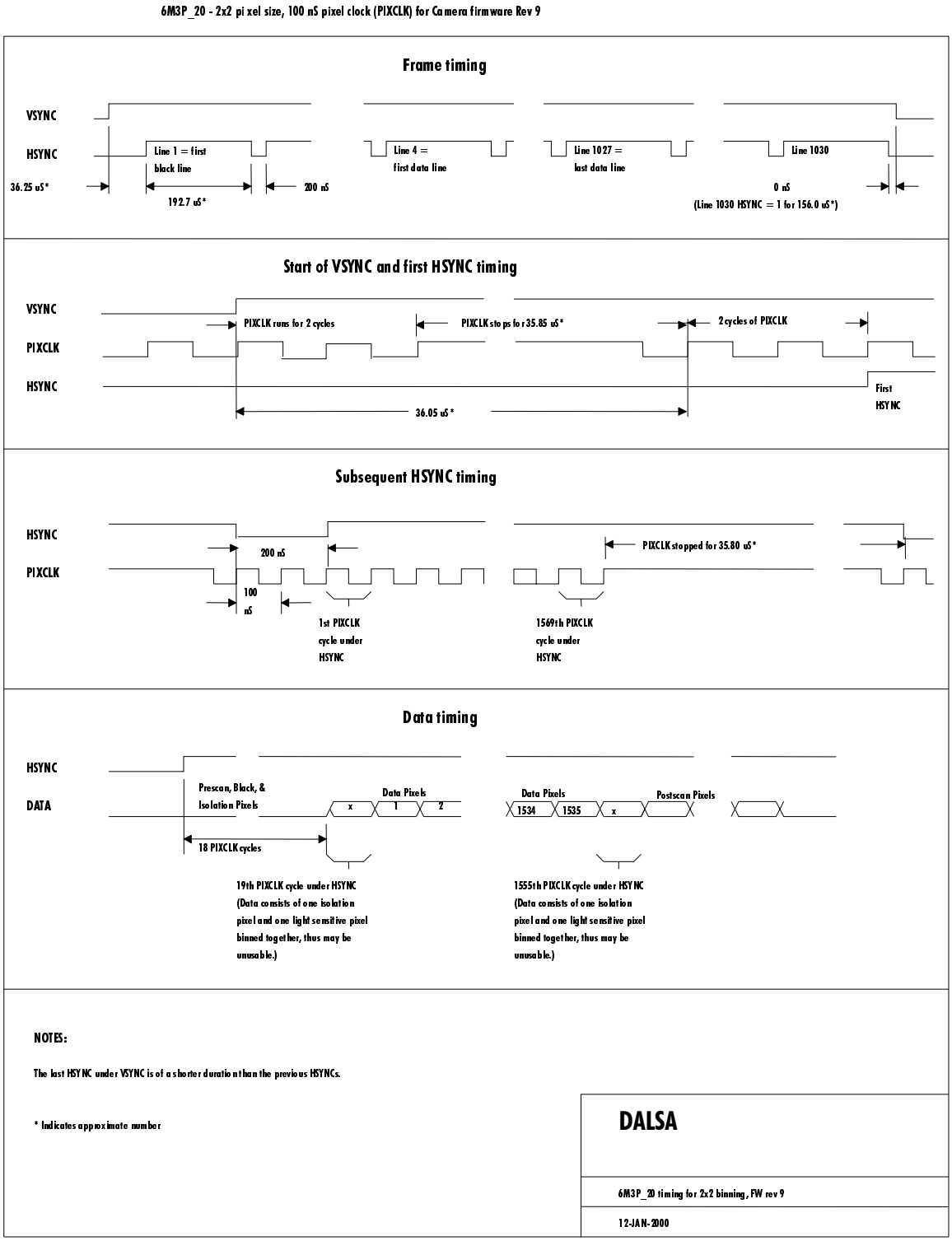
IMPORTANT:
This camera uses the ***falling*** edge of the pixel clock to register data.

Figure 6: Timing Diagrams



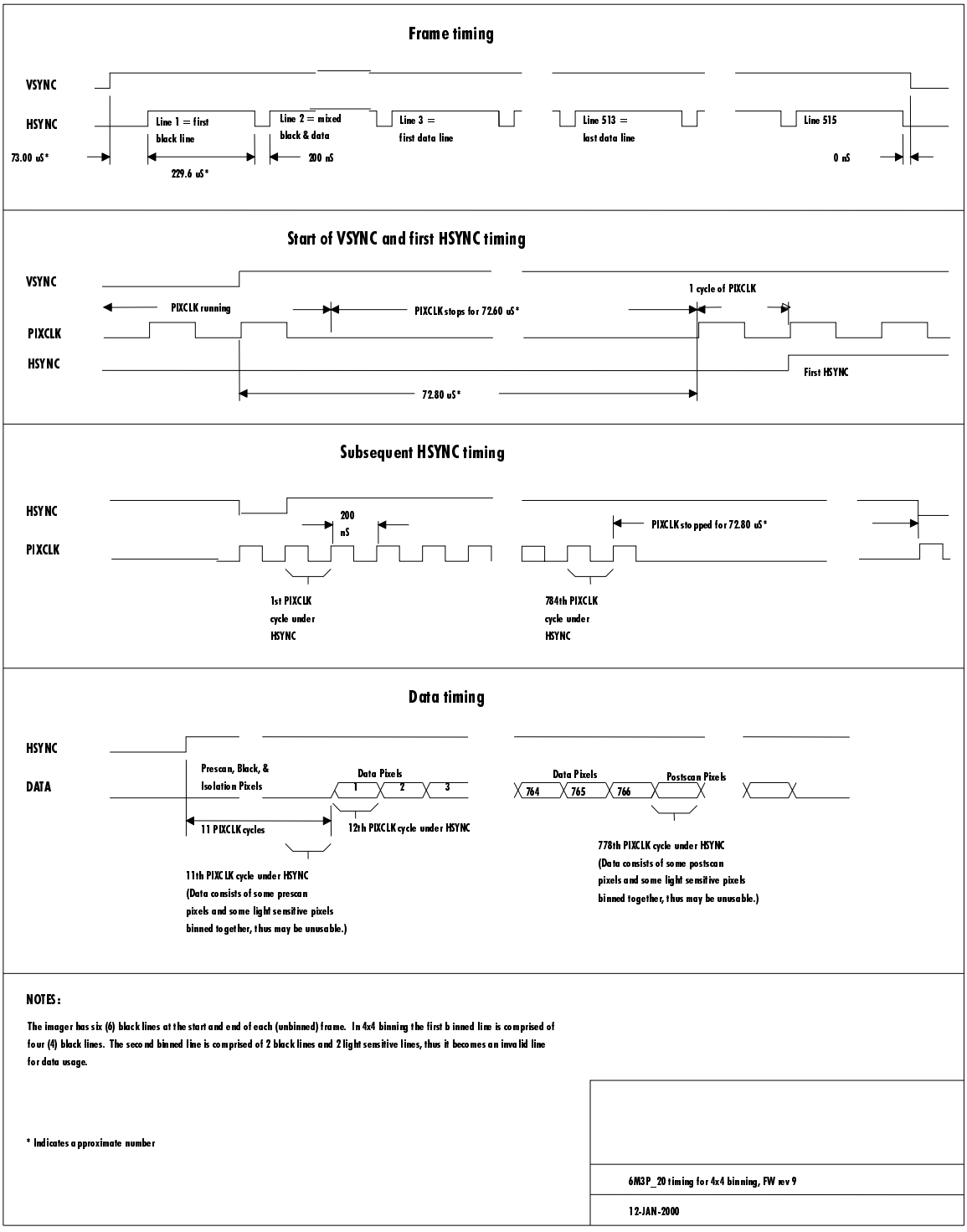
IMPORTANT:
This camera uses the ***falling*** edge of the pixel clock to register data.

Figure 7: 2x2 Binning Timing Diagram



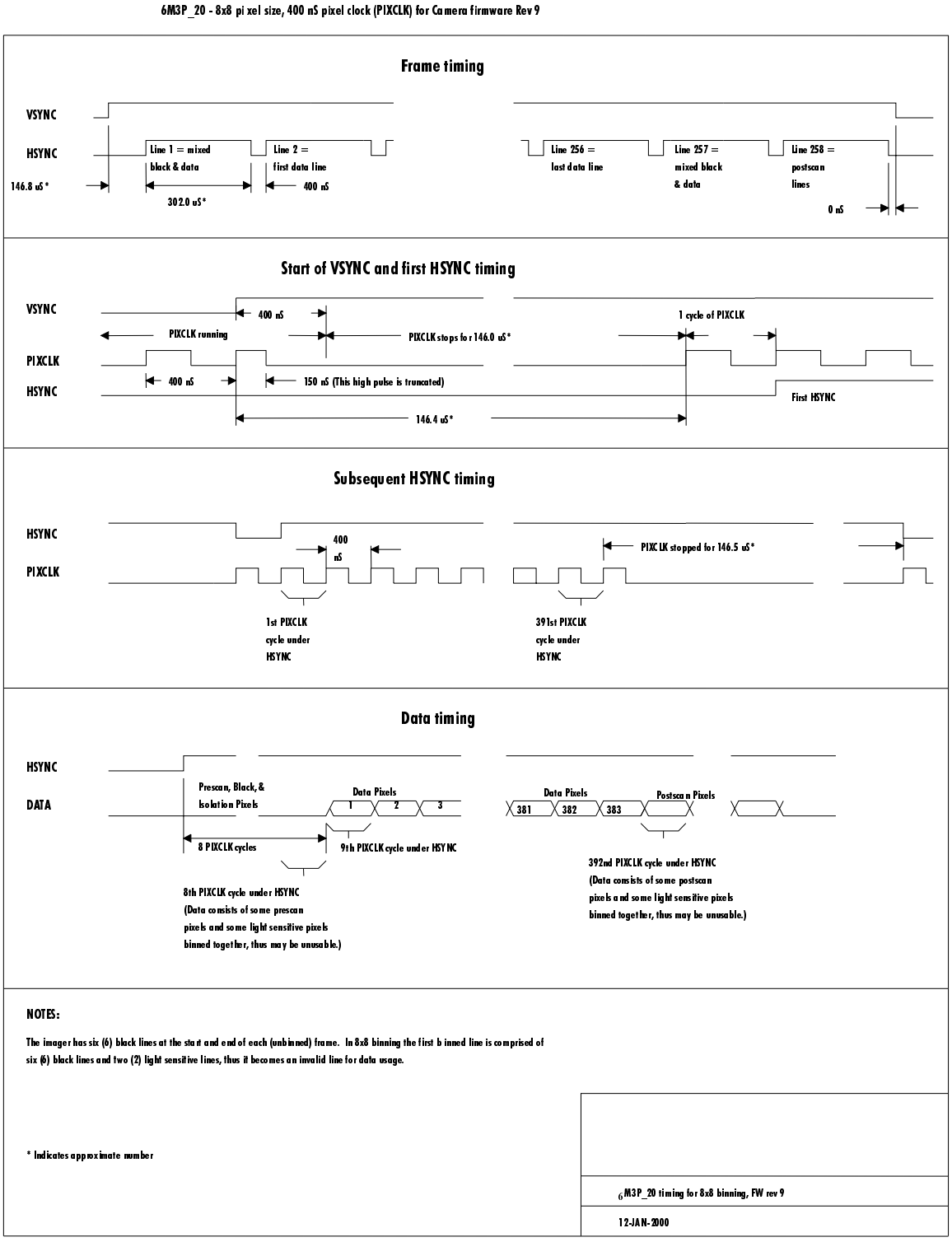
IMPORTANT:
This camera uses the ***falling*** edge of the pixel clock to register data.

Figure 8: 4x4 Binning Timing Diagram


6M3P_20 - 4x4 pi xel size, 200 nS pixel clock (PIXCLK) for Camera firmware Rev 9
Frame timing
VSYNC
HSYNC
73.00 uS*
Line 1 = first black line
229.6 uS*
Line 2 = mixed black & data
200 nS
Line 3 = first data line
Line 513 = last data line
Line 515
0 nS
Start of VSYNC and first HSYNC timing
VSYNC
PIXCLK
HSYNC
PIXCLK running
PIXCLK stops for 72.60 uS*
1 cycle of PIXCLK
First HSYNC
72.80 uS*
Subsequent HSYNC timing
HSYNC
PIXCLK
200 nS
PIXCLK stopped for 72.80 uS*
1st PIXCLK cycle under HSYNC
784th PIXCLK cycle under HSYNC
Data timing
HSYNC
DATA
Prescan, Black, & Isolation Pixels
Data Pixels
1
2
3
11 PIXCLK cycles
12th PIXCLK cycle under HSYNC
11th PIXCLK cycle under HSYNC
(Data consists of some prescan pixels and some light sensitive pixels binned together, thus may be unusable.)
Data Pixels
764
765
766
Postscan Pixels
778th PIXCLK cycle under HSYNC
(Data consists of some postscan pixels and some light sensitive pixels binned together, thus may be unusable.)
NOTES:
The imager has six (6) black lines at the start and end of each (unbinned) frame. In 4x4 binning the first b inned line is comprised of four (4) black lines. The second binned line is comprised of 2 black lines and 2 light sensitive lines, thus it becomes an invalid line for data usage.
* Indicates approximate number
6M3P_20 timing for 4x4 binning, FW rev 9
12-JAN-2000

IMPORTANT:
This camera uses the ***falling*** edge of the pixel clock to register data.

Figure 9: 8x8 Binning Timing Diagram


6M3P_20 - 8x8 pixel size, 400 nS pixel clock (PIXCLK) for Camera firmware Rev 9
Frame timing
VSYNC
HSYNC
146.8 uS*
Line 1 = mixed black & data
302.0 uS*
Line 2 = first data line
400 nS
Line 256 = last data line
Line 257 = mixed black & data
Line 258 = postscan lines
0 nS
Start of VSYNC and first HSYNC timing
VSYNC
PIXCLK
HSYNC
400 nS
PIXCLK running
PIXCLK stops for 146.0 uS*
400 nS
150 nS (This high pulse is truncated)
146.4 uS*
1 cycle of PIXCLK
First HSYNC
Subsequent HSYNC timing
HSYNC
PIXCLK
400 nS
1st PIXCLK cycle under HSYNC
PIXCLK stopped for 146.5 uS*
391st PIXCLK cycle under HSYNC
Data timing
HSYNC
DATA
Prescan, Black, & Isolation Pixels
Data Pixels
1
2
3
8 PIXCLK cycles
9th PIXCLK cycle under HSYNC
8th PIXCLK cycle under HSYNC
(Data consists of some prescan pixels and some light sensitive pixels binned together, thus may be unusable.)
Data Pixels
381
382
383
Postscan Pixels
392nd PIXCLK cycle under HSYNC
(Data consists of some postscan pixels and some light sensitive pixels binned together, thus may be unusable.)
NOTES:
The imager has six (6) black lines at the start and end of each (unbinned) frame. In 8x8 binning the first binned line is comprised of six (6) black lines and two (2) light sensitive lines, thus it becomes an invalid line for data usage.
* Indicates approximate number
6M3P_20 timing for 8x8 binning, FW rev 9
12-JAN-2000

3

Camera Operation

3.1 How to Control the Camera

The 6M3P's RS-232-compatible serial interface allows you to control its configuration and operation, including:

- Triggering Mode
- Binning
- Frame Rate (See also triggering)
- Integration Time
- Gain and Offset

Command Protocol Overview

The camera accepts 8-bit command / value pairs via its RJ-11 serial port using RS-232 compatible signals. Camera commands are "clock" commands, which apply to the electronics that drive the image sensor. These include clock generation, frame rate, integration time, and binning. Each set of commands includes read and write variants. With the exception of reset commands, all 8-bit write commands must be followed by an 8-bit data byte. The commands are interpreted as follows:

Serial Port Configuration	
Baud	9600, fixed
Start bits	1
Data bits	8
Stop bits	1
Parity	None

WARNING: Any commands not listed should be considered invalid. Writing to invalid addresses may overwrite camera calibration information, requiring the camera to be returned for recalibration.

WARNING: Due to initialization sequencing after power-up, no commands should be sent to the camera for a minimum of 1 second after power up.

3.2 Control Register Reference

A number of functions and modes depend on the control register settings. These settings are detailed in the following sections.

The "Write Control Register" command is used to write a register that controls specific camera triggering and test functions. This command must be followed by a data byte with bits defined as shown in the following table.

The "Read Control Register" command allows interrogation of the camera to determine current configuration of the control register.

Table 10: Control Register Bit Definitions

Register	Write Command	Read Command	Bit	Function	Default
Reset	80h		7:0	Resets all registers to default values	NA
Camera Type	NA	C3h	7:0	Read camera type	33h
Firmware Rev	NA	C5h	7:0	Read firmware revision	NA
Register 1	82h	C2h	7	Integration Mode 0=Internal 1=External	0
			6	Video Gain 0=1x 1=4x	0
			5:4	Not Used	0
			3	Trigger Mode 0=Internal 1=External	0
			2	Not Used	0
			1:0	Binning Mode 00=1x1 01=2x2 10=4x4 11=8x8	00
Register 2	84h	C4h	7:0	Pixel Offset MS Byte (Bits 11-4 of 12 bits)	00h
Register 3	88h	C8h	7	Serial Trigger (If Integrate mode=1)	0
			6:4	Not Used	000
			3:0	Pixel Offset LS nibble	000
Write Integration Time LS	8Ah	NA	7:0	LS byte of 24 bit integration time	2Bh
Write Integration Time 2nd	8Bh	NA	7:0	2nd byte of 24 bit integration time	FCh
Write	8Ch	NA	7:0	MS byte of 24 bit	00b

Integration Time MS				integration time	
Write Frame Rate Time LS	8Dh	NA	7:0	LS byte of 24 bit frame rate time	6Bh
Write Frame Rate Time 2nd	8Eh	NA	7:0	2nd byte of 24 bit frame rate time	04h
Write Frame Rate Time MS	8Fh	NA	7:0	MS byte of 24 bit frame rate time	01h

3.3 Reading the Camera Type

This read command returns an 8-bit value unique to the type of camera interrogated. A 6M3P will return a value of 33h when this command is issued. This is useful for applications that need to function with multiple DALSTAR camera types.

Example: Read the camera type

	Command	Value Returned (6M3P)
Binary	1100 0011	0011 0011
Hex	C3h	33h

3.4 Reading the Firmware Revision

This command returns a byte in which the lower nibble is the revision number for the clock board firmware and the upper nibble is undefined. The ability to read this value may assist in customer support issues.

Example: Read the firmware version

	Command
Binary	1100 0101
Hex	C5h

3.5 Resetting the Camera

This is the only other "write" command that is not followed by a data byte. This command resets all clock board registers to their default values (the values used at power-up).

Table 11: Default values in effect after reset

Feature	6M3P Default
Frame Rate (fps)	1
Integration Time (ms)	638
Resolution (pixels)	3072x2048
Video Gain	1x

Binning Mode	1x1
Pixel Offset	0
Synchronization	INTERNAL
Integration Control	INTERNAL
Data Rate (MHz)	20

Example

Use this command to reset the camera:

	Command	Value
Binary	1000 0000	-
Hex	80h	-

3.6 Adjusting Gain

Bit [6] of register 1 is the Video Gain control bit. When this bit=0 the video channel gain=1x. When this bit =1, the video channel gain=4x.

Example

Use this command to set the gain to 4x:

	Command	Value
Binary	1000 0010	*1** ****
Hex	82h	**h

Note: The register containing the Gain bit also controls other configuration data. All bits must be set appropriately.

3.7 Adjusting User Offset

User offset is adjustable from -2047 to +2048 by a 12 bit value as an MS and LS byte. The offset data is only written when the most-significant 8 bits are written to register 2. Therefore, the lower 4 bits should be written first to register 3, followed by the upper 8 bits, which will cause the offset to be applied to the pixel output.

The pixel offset data is written as a 2's compliment number. Therefore either positive or negative offsets can be added to the pixel output to enhance the image contrast.

The offset value that is programmed effects the pixel offset by a ratio of about 8 to 5. So, for that example, if an offset value of a positive 16 is entered to registers 2 and 3 the resulting pixel data will be adjusted by a positive 10.

Table 12:Pixel Offset Examples

Programmed Offset Decimal/2's Complement	Register 3	Register 2	Resulting Pixel Offset
88 (058h)	*8h	05h	55 (37h)
-96 (FA0h – 2's	*0h	FAh	-60 (-FC4h)
152 (098h)	*8h	09h	95 (5Fh)
-2040 (808h)	*8h	80h	-1275 (-4FBh)

The read user offset commands allow the user to read back this information from the camera.

Note: Register 3 contains other configuration data. All bits must bet set to the appropriate values.

Reading Offset from the Camera

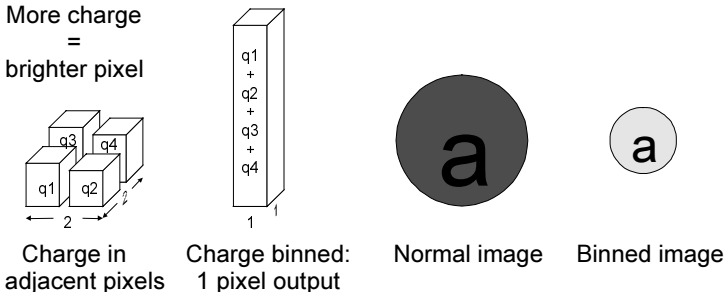
To read the offset setting from the camera, use these commands:

	Read LSB	Read MSB
Binary	1100 1000	1100 0100
Hex	C8h	C4h

3.8 Controlling Binning

Binning increases the camera's light sensitivity by decreasing horizontal and vertical resolution—the charge collected by adjacent pixels is added together.

Figure 10: Example: 2x2 Binning



The 6M3P is capable of up to 8 x 8 binning. To enable binning, you must write bits [1:0] to control register 1.

Binning mode affects the pixel clock rate, maximum frame rate, and readout time. Reference section 3.9 – Triggering, Integration, and Frame Rate Overview.

Example: Setting the camera to 2x2 binning mode

	Write Binning Register with 2x2 mode	
	Command	Value
Binary	1000 0010	**** **01
Hex	82h	**h

Note: The register containing the Binning bits also controls other configuration data. All bits must be set appropriately.

Whenever the camera is in binning mode, the **BIN** LED on the right side of the rear cover will light to indicate the binning mode.

3.9 Triggering, Integration, and Frame Rate Overview

Image capture triggering, integration, and frame rate are closely related.

- With electronic shuttering, integration time can be less than 1/frame rate, but it can never be greater than 1/frame rate.
- You can program fixed integration and frame rates (or use defaults) and let the camera "free run."
- You can program fixed integration time and supply a (asynchronous) trigger signal to control frame rate, either by toggling a bit or by supplying a TTL pulse on the SMA connector. This is referred to as "Programmed Integration/External Trigger Mode."
- You can also have the camera integrate as long as an asynchronous TTL pulse is held high. This pulse will therefore control both integration time and frame rate. This is also known as "External Integrate Mode."

For a given frame rate, the maximum integration time is limited to the frame period less an overhead factor required for proper operation of the CCD. Maximum integration time is defined by this equation:

$$\text{Max Integration Time} = (1/\text{Frame Rate}) - \text{Readout Time}$$

This equation is valid for all binning modes, free running, external trigger and external integrate modes.

Note that binning mode impacts the Read Time and limits Integration Time.

WARNING: Do not set integration time higher than the limits of the equation above. Unpredictable operation may result

Table 13: Integration/Frame Rate Limits

Binning	Read out Time (mS)	Max Frame Rate	Data Rate (MHz)	Integration Value (µs)	Max Integration Register
1 x 1	359.50	2.75	20	327686	050006h

Binning	Read out Time (mS)	Max Frame Rate	Data Rate (MHz)	Integration Value (µs)	Max Integration Register
2 x 2	198.70	5.00	10	180130	02BFA2h
4 x 4	118.42	8.25	5	109382	01AB46h
8 x 8	78.25	12.50	2.5	72175	0119EFh

The default shutter time was chosen to give a frame rate of 2.75 fps (see section *3.11 Controlling Frame Rate*). Changing the shutter time involves writing to the three shutter time registers.

3.10 Controlling Integration (Shutter Time)

The 6M3P allows you to control integration (also known as exposure time or shutter time) in five ways.

- **Programmed Integration/Free Running**: (default) The camera free runs with the internally programmed integration time and frame rate
- **Programmed Integration/SMA Trigger:** The camera will integrate for the internally programmed time when triggered by a TTL high pulse on the SMA connector.
- **Programmed Integration/Serial trigger:** The camera will integrate for the internally programmed time when triggered by high signal on the serial interface.
- **External Integration/SMA Trigger:** The camera will integrate as long as the TTL pulse on the TRIGGER IN SMA connector is high. The integration time is effectively the input pulse width. In this mode, TRIGGER IN also controls the frame rate.
- **External Integration/Serial Trigger:** The camera will integrate as long as the serial bit is held high. The integration time is effectively the input pulse width. In this mode, the serial signal also controls the frame rate. Due to variation in the host operating system, this mode is generally used only for camera setup and functional testing.

The register settings required for each mode are defined in the following table

Table 14: Integration/Trigger Modes

Mode	Register 1 Bit [7] INTEGRATE	Register 1 Bit [3] EXT Trigger
Programmed Integration / Free Running	0	0
Programmed Integration / SMA Trigger	0	1
Programmed Integration / Serial Trigger	0	1
External Integration / SMA Trigger	1	1
External Integration / Serial Trigger	1	1

* Indicates bit state not considered

Whenever the Integrate Mode or External Trigger Mode bits are set the **MODE** LED on the right side of the rear cover will light to indicate that an externally synchronized mode is active.

Free Running (Programmed Integration):

This mode is the camera's default. The camera speed is controlled by writing a 3-byte integration time value (in µs) to the three Integration Time registers. These three bytes are then combined to form a 24 bit integration time. The number represents the integer number of microseconds the camera will collect light. The number programmed in the three registers should not be below 10 µS (0000Ah). The camera will run at maximum speed for the programmed integration time.

The camera's default integration time value is 638 ms which achieve 1 fps.

Example: Set integration time to 1000ms

1. Using the command 82h, set bit [7] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 0 (Trigger Mode = Internal).

2. Use commands 8Ah, 8Bh, 8Ch to set the 24-bit integration time value.

Value = 1000ms

= 1000000μs

= F4240h

	Write Integration LS Byte		Write Integration Center Byte		Write Integration MS Byte	
	Command	Value	Command	Value	Command	Value
Binary	1000 1010	0100 0000	1000 1011	0100 0010	1000 1100	0000 1111
Hex	8Ah	40h	8Bh	42h	8Ch	0Fh

Programmed Integration/SMA Trigger

For external SMA controlled triggering with a programmed integration time, a TTL rising edge on the **TRIGGER IN** (or SYNC) signal triggers the camera to acquire one frame of data. Integration begins within 200ns after the rising edge and stops when the programmed integration time has completed. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out.*

When the camera is in External Trigger Mode, the Frame LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector or serial bit [7].

Because this signal is internally OR'ed with the Serial Trigger input, care must be taken to ensure the serial bit [7] of register 3 is equal to a logic 0 while in SMA Trigger mode.

Programmed Integration/Serial Trigger

For external serial controlled triggering with a programmed integration time, a TTL rising edge on bit [7] of serial register 3 triggers the camera to acquire one frame of data. Integration begins within 200ns after the rising edge and stops when the programmed integration time has completed. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out*.

When the camera is in External Trigger Mode, the Frame LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector or serial bit [7].

Because this signal is internally OR'ed with the TRIGGER IN Sync input, care must be taken to ensure the TRIGGER IN signal is equal to a logic 0 while in Serial Trigger mode.

External Integration/SMA Trigger

When in External Integrate / SMA mode, a TTL rising edge on the **TRIGGER IN** (or SYNC) signal triggers the camera to acquire one frame of data. Integration begins within 200ns after the rising edge and stops within 550 ns after the falling edge. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out*. This means in this mode TRIGGER IN necessarily controls both integration and frame rate.

When the camera is in External Trigger Mode, the Frame LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector or serial bit [7].

Because this signal is internally OR'ed with the Serial Trigger input, care must be taken to ensure the serial bit [7] of register 3 is equal to a logic 0 while in SMA Trigger mode.

External Integration/Serial Trigger

When in External Integration / Serial mode, a TTL rising edge on serial bit [7] of register 3 triggers the camera to acquire one frame of data. Due to variation in the host operating system, this mode is generally used only for camera setup and functional testing. Integration begins within 200ns after the rising edge and stops within 550 ns after the falling edge. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out*.

This means in this mode TRIGGER IN necessarily controls both integration and frame rate.

When the camera is in External Trigger Mode, the Frame LED will be illuminated on the camera back to indicate the camera is expecting a signal on the SMA connector or serial bit [7].

Because this signal is internally OR'ed with the TRIGGER IN Sync input, care must be taken to ensure the TRIGGER IN signal is equal to a logic 0 while in Serial Trigger mode.

3.11 Controlling Frame Rate

The 6M3P allows you to control frame rate in three ways.

- **Free Running (Programmed Frame Rate):** (default) The camera free runs with the internally programmed frame rate time and integration time.
- **External Trigger/Internal Integration:** The camera frame rate will be controlled by the TTL pulse on the TRIGGER IN SMA connector. The camera will integrate for the programmed integration time. (*Reference section 3.10 Controlling Integration Mode*)
- **External Integration:** The camera frame rate will be controlled by the TTL pulse on the TRIGGER IN SMA connector. The camera will integrate for as long as the pulse is held high. In this mode, TRIGGER IN also controls integration. (*Reference section 3.10 Controlling Integration Mode*)

Free Running (Programmed Fame Rate)

This mode is the camera's default. To specify programmed frame rate, you must set bit [7] of register 1 to 0 (Integrate Mode = Internal), and bit [3] of register 1 to 0 (Trigger Mode = Internal). Next, write the 3-byte frame rate value (in µs or 1/Frame Rate) to the three Frame Rate registers. These three bytes are then combined to form a 24 bit frame rate time. The number represents the integer number of microseconds between frames. The number programmed in the three registers should not be below 10 µS (0000Ah), nor above the calculated value noted in section *3.9 Triggering, Integration, and Frame Rate Overview*.

Example: Set the Frame Rate to 2.5 fps

1. Reference section 3.9 Triggering, Integration, and Frame Rate Overview to ensure the desired frame rate can be supported for the selected binning and integration modes.
2. Using the command 82h, set bit [7] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 0 (Trigger Mode = Internal).

   NOTE: All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.
3. Use commands 8Dh, 8Eh, 8Fh to set the 24-bit Frame Rate time value.

$$\text{Value} = 1/2.5s$$

$$= 400000\mu s$$

$$= 61A80h$$

	Write Frame Rate LS Byte		Write Frame Rate Center Byte		Write Frame Rate MS Byte	
	Command	Value	Command	Value	Command	Value
Binary	1000 1101	1000 0000	1000 1110	0001 1010	1000 1111	0000 0110
Hex	8Dh	80h	8Eh	1Ah	8Fh	06h

External Trigger/Programmed Integration

This is the same as External Integrate / SMA Trigger Mode. Reference to section 3.10 Controlling Integration Mode.

Example: Set the Frame Rate to 2.5 fps

1. Reference section 3.9 Triggering, Integration, and Frame Rate Overview to ensure the desired frame rate can be supported for the selected binning and integration modes.
2. Using the command 82h, set bit [7] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 1 (Trigger Mode = External).

   NOTE: All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.
3. Set the desired integration time per section 3.10 – Controlling Integration.
4. Each TTL rising edge on the SMA connector will initiate a new frame of data, using the programmed integration time. To achieve 2.5 fps, a TTL pulse must be sent to the camera every 400 ms (1 / 2.5).

External Trigger/Serial Connector

This is the same as External Integrate / External Trigger Mode. Refer to section 3.10 Controlling Integration Mode.

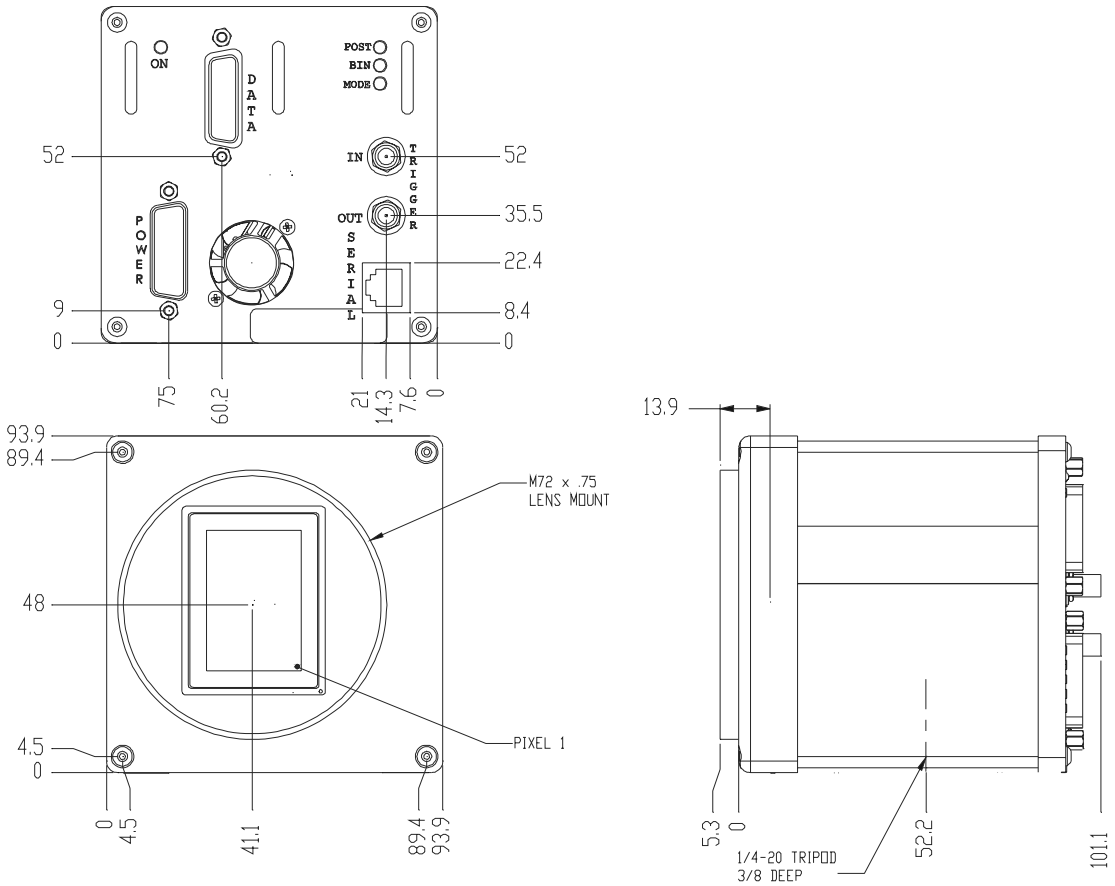
4

Optical and Mechanical Considerations

4.1 Mechanical Interface

An M72-Fmount adapter is available from DALSA. Contact DALSA sales for more information.

Figure 11: Camera Dimensions



4.2 Mechanical Tolerances

Table 15: Mechanical Tolerances

Additional Dimensions	
Center of sensor with respect to lens mount	<.020"
Planarity of lens flange to sensor	<.010"
Rotation of sensor	<.3°

4.3 Mounting the Camera

The 6M3P can be mounted via the3/8" deep, 1/4"-20 threaded tripod mount located on the bottom of the camera.

5

Cleaning and Maintenance

5.1 Cleaning

Electrostatic Discharge and the CCD Sensor

Charge-coupled device (CCD) image sensors are metal oxide semiconductor (MOS) devices and are susceptible to damage from electrostatic discharge (ESD). Although many sensor pins have ESD protection circuitry, the ESD protection circuitry in CCDs is typically not as effective as those found in standard CMOS circuits.

Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. When charge buildup occurs, surface gated photodiodes (SGPDs) may exhibit higher image lag. Some SGPD sensors may also exhibit a highly non-uniform response when affected by charge build-up, with some pixels displaying a much higher response when the sensor is exposed to uniform illumination. The charge normally dissipates within 24 hours and the sensor returns to normal operation.

Preventing ESD Damage

To prevent ESD damage, DALSA advises you to take the following handling precautions.

1. Ground yourself prior to handling CCDs.
2. Ensure that your ground and your workbench are also properly grounded. Install conductive mats if your ground or workbench is non-conductive.
3. Use bare hands or non-chargeable cotton gloves to handle CCDs. NOTE: Rubber fingercots can introduce electrostatic charge if the rubber comes in contact with the sensor window.
4. Handle the CCD from the edge of the ceramic package and avoid touching the sensor pins.
5. Do not touch the window, especially in the region over the imaging area.

6. Ground all tools and mechanical components that come in contact with the CCD.
7. DALSA recommends that CCDs be handled under ionized air to prevent static charge buildup.
8. Always store the devises in conductive foam. Alternatively, clamps can be used to short all the CCD pins together before storing.

The above ESD precautions need to be followed at all times, even when there is no evidence of CCD damage. The rate which electrostatic charge dissipates depends on numerous environmental conditions and an improper handling procedure that does not appear to be damaging the CCDs immediately may cause damage with a change in environmental conditions.

Protecting Against Dust, Oil, and Scratches

The CCD window is part of the optical path and should be handled like other optical components, with extreme care.

Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

Dust can normally be removed by blowing the window surface using clean, dry, compressed air, unless the dust particles are being held by an electrostatic charge, in which case either an ionized blower or wet cleaning is necessary.

Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber fingercots and rubber gloves can prevent contamination. However, the friction between rubber and the window may produce electrostatic charge that may damage the sensor. To avoid ESD damage and to avoid introducing oily residues, only hold the sensor from the edges of the ceramic package and avoid touching the sensor pins and the window.

Scratches can be caused by improper handling, cleaning or storage of the sensor. Vacuum picking tools should not come in contact with the window surface. CCDs should not be stored in containers where they are not properly secured and can slide against the container.

Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels will change with the angle of illumination.

Cleaning the Sensor Window

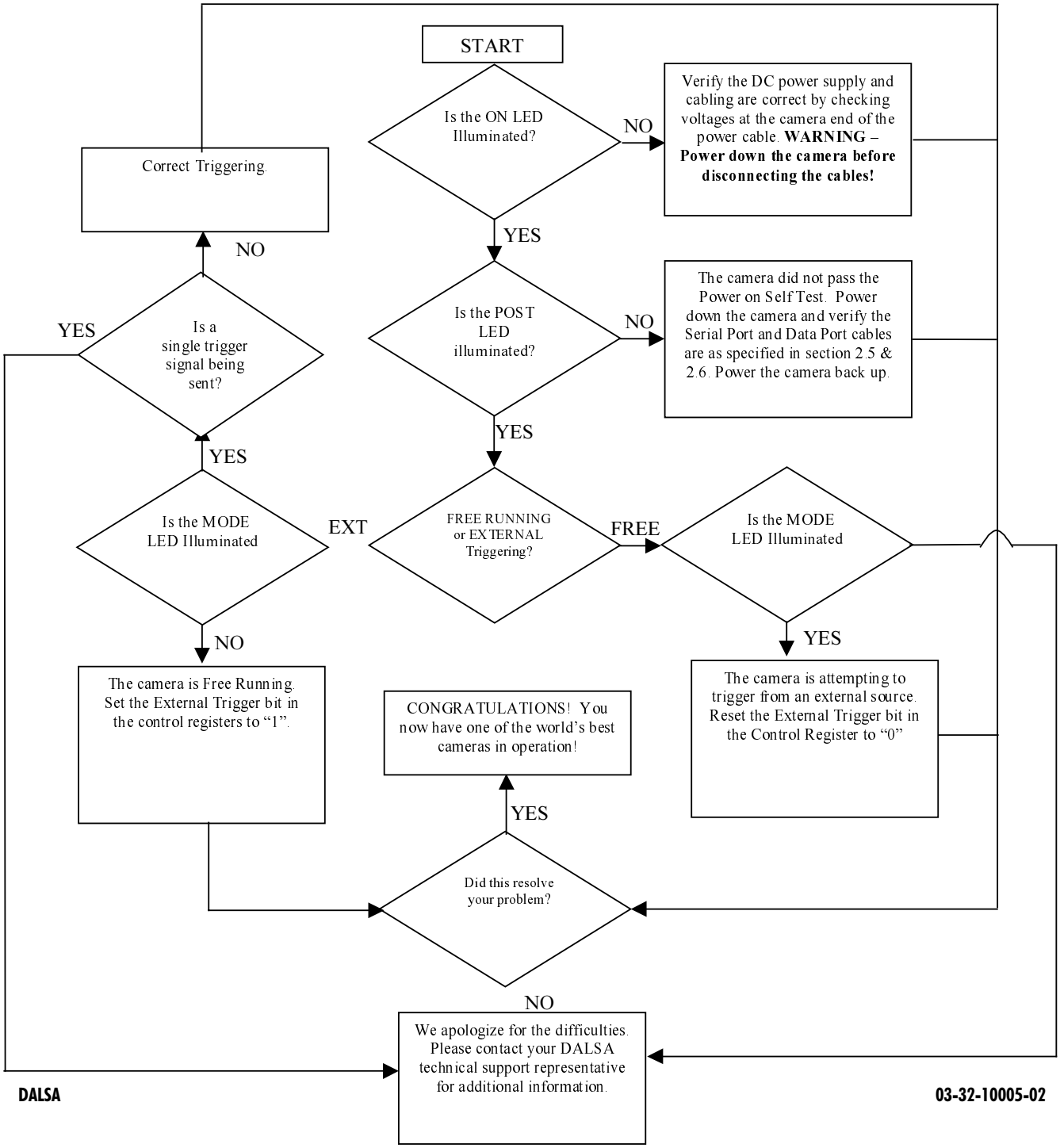
1. Use clean, dry, compressed air to blow off loose particles. This step alone is usually sufficient to clean the sensor window.
2. If further cleaning is required, use a lens wiper moistened with alcohol.
3. We recommend using lint free, ESD safe cloth wipers that do not contain particles that can scratch the window.
4. Wipe the window carefully and slowly.

5.2 Maintenance

There are no user serviceable parts on this camera. Please contact DALSA service.

6

Troubleshooting


START
Is the ON LED Illuminated?
NO
Verify the DC power supply and cabling are correct by checking voltages at the camera end of the power cable. WARNING – Power down the camera before disconnecting the cables!
YES
Is the POST LED illuminated?
NO
The camera did not pass the Power on Self Test. Power down the camera and verify the Serial Port and Data Port cables are as specified in section 2.5 & 2.6. Power the camera back up.
YES
FREE RUNNING or EXTERNAL Triggering?
EXT
FREE
Is the MODE LED Illuminated
YES
The camera is attempting to trigger from an external source. Reset the External Trigger bit in the Control Register to "0"
Is the MODE LED Illuminated
NO
The camera is Free Running. Set the External Trigger bit in the control registers to "1".
YES
Is a single trigger signal being sent?
NO
Correct Triggering.
CONGRATULATIONS! You now have one of the world's best cameras in operation!
YES
Did this resolve your problem?
NO
We apologize for the difficulties. Please contact your DALSA technical support representative for additional information.

7

Warranty

7.1 Limited One-Year Warranty

What We Do

This product is warranted by DALSA for one year from date of original purchase. Please refer to your Purchase Order Confirmation for details.

What is Not Covered

This warranty does not apply if the product has been damaged by accident or misuse, or as a result of service or modification by other than DALSA, or by hardware, software, interfacing or peripherals not provided by DALSA. DALSA shall have no obligation to modify or update products once manufactured. This warranty does not apply to DALSA Software Products.

Note: if the camera has a non-standard cover glass (e.g. taped) the warranty is void on the CCD.

How to Obtain Service for Your Equipment

If you want to return your product for repair, contact DALSA Customer Service in order to obtain a Return Goods Authorization form. Repair cannot begin until the form is issued, completed, and returned to DALSA

DALSA Technical Support

Phone: 519 886 6000
Fax: 519 886 8023
email: support@DALSA.com

Index

A

About DALSA, 2
Aperture, 8
Applications, 5

B

baud, 15
BIN LED, 11
Binning, 25

C

Calibration Conditions, 8
Clocking Signals, 14
Command Protocol Overview, 21
Connector, 14, 16
connectors, 12
Connectors, 13
Control Register, 22

D

data bits, 15
Data Rate, 8
DTE, 14
Dynamic Range, 9

E

electronic shuttering, 26
External Integrate Mode, 29, 31

F

Features, 5
Firmware Revision, 23
Frame Rate, 8, 30

G

Gain
  adjusting, 24
Gain Range, 8

H

hard reset, 23
HSYNC, 14

I

Image Sensor, 6
  Image Sensor Block Diagram, 6
Installation Overview, 10
Integration Mode, 27
integration time, 26

L

LED Status Indicators, 11

M

Mass, 8
Mechanical Interface, 33
MODE LED, 11

O

ON LED, 11
Operating Ranges, 8
Operating Temp, 8

P

parity, 15
Performance Specifications, 8
Physical Characteristics, 8
pinout, 12
Pinout, 13, 14
PIXCLK, 14
Pixel Size, 8
POST LED, 11
Power Dissipation, 8
power supply, 12

R

Resolution, 8
RJ-11, 14

S

Serial Communication, 14
Size, 8
Specifications, 8
start bit, 15
State diagrams, 20
stop bit, 15

T

Technical Support, 38
telephone-style connector, 14
Temperature, 8
Timing diagrams, 20
Triggering, 26
TTL Trigger, 16

V

Video Timing, 20
VSYNC, 14

W

Warranty, 38